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# BUILDABILITY AS TOOL FOR OPTIMISATION OF BUILDING DEFECTS

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*Defects in buildings harm the reputation of the construction industry and the amount of defects is believed to represent a loss in economy. The purpose is to study whether the buildability concept could serve as an efficient tool for reduction of defects. The project includes a literature study and the development of a technical-probabilistic perspective on the building process in which an optimal amount of defects exists. Three levels of risk are defined as a basis for proposing strategies for forming rules for optimisation of defects. It is concluded that a dynamic and flexible approach is needed, because different rules apply to different situations during the building period and because the economic potentials in better planning and in savings by a reduction of defects are different for different types of buildings.*

**KEYWORDS:** buildability, buildings, defects, risk

## INTRODUCTION

Defects are often exposed in public media harming the reputation of the construction industry. The costs caused by defects are believed to represent a considerable loss in the economy. An approach where the number of building defects for different alternative technical solutions are mapped in order to avoid those with a high score as non-buildable in future designs may not lead to an improved economy, because an alternative technical solution may be considerably more expensive or have a poor building performance. This approach may also block for innovation since innovative solutions normally contain more defects than traditional ones.

The purpose of the project is to study whether the buildability concept, based on a technical-probabilistic perspective on the building process, offers a more adequate approach.

## THEORETICAL FRAMEWORK

The theoretical framework consists of a perception of the building process being a probabilistic process, risk assessment, the engineering method, buildability and quality management.

### A probabilistic perception of the building process

The building process is perceived as a process with many possible paths leading to a finished work. A deterministic view implies that, in considering all these paths, an optimal design may be developed, described and communicated to people involved in the building project so that no mistake is done. If

not impossible in practice, such a deterministic approach will obviously be extremely expensive.

A probabilistic approach considers that design and planning must stop at a certain stage and that some decisions concerning details are to be taken in the construction phase. In this approach the expertise at the construction site is used.

### The engineering method

Koen (2003) defines the engineering method as *the use of heuristics* (rules of thumbs) *to cause the best change in a poorly understood situation within the available resources*. It is argued that in this perspective an optimal amount of defects exists.

### Risk assessment

Defects are categorised by their consequences. Three risk levels are considered: Risk for lives and health, Risk for large economic losses, and Risk for small economic losses. The differentiation in risk levels calls for a flexible approach to risk assessment with rules that focus on different phases of the building process.

### Buildability

In the late 1970s *buildability* emerged as an area of research, based on the assumption that buildability problems exist because of the comparative isolation of many designers from the practical construction process (Chen and McGeorge 1994). A widely accepted definition of buildability is: *the extent to which the design of the building facilitates the ease of construction, subject to the overall requirements for the completed building* (CIRIA, 1983), focusing on how to improve the productivity.

Buildability and the corresponding term *constructability* are both connected with 'ease of construction' which is highly relevant for an evaluation of risk of defects. In order to focus on defects the definition of buildability is here modified to: *The extent to which the management of the building process, the design, the skills of the workers involved and the circumstances at the construction site decreases the probability of a defect, either during construction or in the completed building.* This definition combines the theoretical aspects presented above with aspects of the CIRIA-definition of buildability (review at an early stage) with the wider perspective of the term constructability, e.g. (Adams, 1989) and (Chen and McGeorge, 1994) as well as the definition of a constructability program as found in (ASCE, 1991).

### IMPLICATIONS OF A TECHNICAL-PROBABILISTIC PERSPECTIVE

In line with the probabilistic approach, different strategies and approaches to optimisation of defects should be adopted, dependent on the type of risk and which part in the building process they address. Quality management according to (ISO, 2008) may serve as an adequate framework, but it shall be implemented as a flexible tool which reflects different types of risk elements.

Buildability with a strong focus on evaluation of risk of defects seems adequate as a platform for formulating rules leading to an optimum of defects. In agreement with the engineering method, such rules may be as simple as just rules of thumbs, while in other cases guidelines or even law requirements are needed. Many of the elements in existing guidelines for buildability or constructability are relevant in this context, e.g. 'consider access', 'use suitable materials', 'design for skills available', and 'simplify construction' (Adams, 1989).

Can evaluation of buildability, in practice, significantly improve the likelihood of few building defects? Can the costs for evaluation and for defect preventing measures, including the possible choice of an alternative design, be kept small enough to ensure an increased productivity?. Due to the nature of the problem no final answers can be given, but the analysis suggests that it is possible to move to a more optimal amount of defects by obeying to the approaches as presented in the full paper. This may include development of specific tools and guidelines, especially for project reviews at the design stage in order to reduce the risk for large economic losses. However, the challenge is to develop a set of different rules of thumbs to be used at different stages during the

building process in order to reduce the risk for many small economic losses.

### CONCLUSIONS

A technical-probabilistic perspective on the construction process is developed. It implies that there is an optimal amount of defects.

A redefinition of the buildability concept with a stronger focus on defects is suggested as a necessity for buildability to become an efficient tool in the optimisation of defects.

Three levels of risk are defined as a basis for proposing strategies and rules for evaluation of risk of defects.

It is found that the approach for forming rules for optimisation of defects shall be flexible, dynamic and multi-focused for the following reasons: 1) decisions associated with defects are made at all levels and through the whole building process, 2) the economic potentials in better planning and in savings by a reduction of defects are different for different types of buildings, 3) the challenges in construction changes with time, and 4) risks may originate from the type of contract, management, the design/complexity of the solution, worker skills and conditions at the construction site.

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